REMARKS

I. INTRODUCTION

In response to the Office Action dated May 29, 2008, which was made final, and in conjunction with a Request for Continued Examination (RCE) submitted herewith, claim 5 has been canceled, and claims 1, 10 and 11 have been amended. Claims 1, 6-16 remain in the application. Re-examination and re-consideration of the application, as amended, is requested.

II. PRIOR ART REJECTIONS

A. The Office Action Rejections

In paragraphs (1)-(2) of the Office Action, claims 1, 5-12, and 16 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dwilinski et al., U.S. Publication No. 2006/0138431 (Dwilinski) in view of Hata, U.S. Patent No. 6,977,953 (Hata). In paragraph (3) of the Office Action, claims 13-15 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dwilinski in view of Hata and in further view of Nagahama et al., U.S. Patent No. 6,677,619 (Nagahama).

Applicants' attorney respectfully traverses these rejections.

B. The Dwilinski Reference

Dwilinski describes a high-output type nitride light emitting device. The nitride light emitting device comprises an n-type nitride semiconductor layer, a p-type nitride semiconductor layer and an active layer therebetween, wherein the light emitting device comprises a gallium-containing nitride semiconductor layer prepared by crystallization from supercritical ammonia-containing solution in the nitride semiconductor layer.

C. The Hata Reference

Hata describes a nitride-based semiconductor light-emitting device capable of stabilizing transverse light confinement. This nitride-based semiconductor light-emitting device comprises an emission layer, a cladding layer, formed on the emission layer, including a first nitride-based semiconductor layer and having a current path portion and a current blocking layer, formed to cover the side surfaces of the current path portion, including a second nitride-based semiconductor layer, while the current blocking layer is formed in the vicinity of the current path

portion and a region having no current blocking layer is included in a region not in the vicinity of the current path portion. Thus, the width of the current blocking layer is reduced, whereby strain applied to the current blocking layer is relaxed. Consequently, the thickness of the current blocking layer can be increased, thereby stabilizing transverse light confinement.

D. The Nagahama Reference

Nagahama describes a nitride semiconductor device including a light emitting device comprises a n-type region of one or more nitride semiconductor layers having n-type conductivity, a p-type region of one or more nitride semiconductor layers having p-type conductivity and an active layer between the n-type region and the p-type region. In such devices, there is provided with a super lattice layer comprising first layers and second layers which are nitride semiconductors having a different composition respectively. The super lattice structure makes working current and voltage of the device lowered, resulting in realization of more efficient devices.

E. Applicants' Claimed Invention is Patentable over the References

Applicants' invention, as recited in amended independent claims 1, 10 and 11, is patentable over the references, because these claims recite limitations not shown by the references, taken individually or in combination.

The Office Action, on the other hand, asserts the following (with regard to independent claim 1 and dependent claim 5; similar assertions are made with regard to independent claims 10 and 11):

> Regarding claim 1, Dwilinski teaches the method for forming a nitride semiconductor device, comprising: (a) growing one or more gallium nitride (GaN) layers on a substrate (claim 10, pars. 59, 108-111); and (b) growing one or more non-polar a plane (Al,In,Ga)N layers off of a grown surface of the GaN layers (par. 16, claim 10) to form at least one non-polar a-plane quantum well. Dwilinski lacks growing Boron to form the one or more non-polar a-plane (Al,B,In,Ga)N layers off of a grown surface of the GaN layers.
>
> However, Hata teaches (col. 9, ll. 40-45 and col. 52, l. 43 - col. 53, l. 4) using boron in a composition of (Al,Ga,In)N to form at least one quantum well.
>
> Since both Hata and Dwilinski teach the method of forming a nitride semiconductor device above, it would have been obvious to include boron for forming the one or more non-polar a-plane (Al,B,In,Ga)N layers off of a grown

surface of the GaN layers of Hata in Dwilinski for the benefit of obtaining a desired emission spectra (col. 52, l. 43 – col. 53, l. 4).

Regarding claim 5, Dwilinski teaches (pars. 15-17, GaN planes: par. 109, substrate planes: claim 3) the method above, wherein the GaN layers are non-polar a-plane GaN layers and the substrate is an r-plane substrate for the same benefit of improving the performance of state-of-the-art optoelectronic and electronic devices by making quantum structures not influenced by polarization-induced electric fields.

Applicants' attorney respectfully disagrees with this analysis. Specifically, in Applicants' invention, non-polar a-plane (Al,B,In,Ga)N layers are formed on a grown surface of non-polar a-plane GaN template layers deposited on an r-plane substrate to form non-polar a-plane quantum wells. This contrasts with Dwilinski, which deposits non-polar gallium-containing nitride layers only on a cut surface of a nitride bulk single crystal.

Consider, for example, the cited portions of Dwilinski and Hata, which are set forth below:

Dwilinski: Paragraphs [0015]-[0017]

[0015] The second invention is characterized in that the substrate is the gallium-containing nitride bulk single crystal prepared by crystallization from supercritical ammonia-containing solution, which leads to a light emitting device with lower dislocation density by the combination of the first invention and the second invention. Moreover, the substrate in the light emitting device structure has at least one plane selected from the group comprising A-plane, M-plane, R-plane, C-plane, {1-10n (n is a natural number)}, and {11-2m (m is a natural number)} of the gallium-containing nitride bulk single crystal, as its own surface.

[0016] According to the present invention, a nitride bulk single crystal shown in Drawings can be prepared by applying the AMMONO method, therefore A-plane or M-plane which is parallel to C-axis of hexagonal structure for an epitaxial growth can be obtained. (FIG. 9) In the present invention, an epitaxial growth required by a device structure can be carried out in case that the plane has the area of 100 mm.sup.2. A-plane and M-plane are non-polar, unlike C-plane. **In case that A-plane or M-plane of the gallium-containing nitride is used as a plane for depositing of layers**, there can be obtained a laser device having no cause of the deterioration of the performance such as the red shift of light emitting, recombination degradation and increase of the threshold current. According to the present invention, when the nitride semiconductor laser device is grown on A-plane of the GaN substrate prepared by crystallization from supercritical ammonia-containing solution, the active layer of the laser device is not subject to the polarization effect. In such a case, the light emitting face of the resonator will be M-plane, on which M-plane end face film can be formed and thus cleavage is easily performed. In case that the nitride semiconductor laser device is grown on M-plane of the GaN substrate prepared by crystallization from

supercritical ammonia-containing solution, the active layer is not subject to the polarization effect and A-plane end face film being non-polar can be obtained on the light emitting face of the resonator.

[0017] According to the present invention, a substrate for growth means not only a substrate of only gallium-containing nitride but also a composite substrate (template) which comprises gallium-containing nitride grown on a heterogeneous substrate. In case that the gallium-containing nitride is formed on a heterogeneous substrate by crystallization from supercritical ammonia-containing solution, first GaN, AlN or AlGaN layer is preformed on the heterogeneous substrate and then the gallium-containing nitride is formed thereon.

Dwilinski: Paragraph [0059]

[0059] The schematic cross-sectional view of the semiconductor laser according to the present invention is shown in FIG. 1. On the substrate 1 for growth, the n-type nitride semiconductor layer 2 and the p-type nitride semiconductor layer 4 are formed. Between them there is the active layer 3 of a single quantum well or a multi quantum well structure in the form of an In-containing nitride semiconductor. This results in the laser device having a good light emitting efficiency at the wavelength region between near-ultraviolet and green visible light (from 370 nm to 550 nm). The n-type nitride semiconductor layer 2 is composed of an n-type contact layer 21, a InGaN crack-preventing layer 22, an n-type AlGaN clad layer 23 and an n-type GaN optical guide layer 24. The n-type contact layer 21 and the crack-preventing layer 22 can be omitted. The p-type nitride semiconductor layer 4 is composed of a cap layer 41, a p-type AlGaN optical guide layer 42, a p-type AlGaN clad layer 43 and a p-type GaN contact layer 44. According to the present invention, gallium-containing nitride semiconductor layer prepared by the crystallization from supercritical ammonia-containing solution can be used in the n-type nitride semiconductor layer 2 or p-type nitride semiconductor layer 4. The substrate 1 is comprised with a bulk single crystal and the dislocation thereof is remarkably low, i.e. about 10.sup.4/cm.sup.2. Therefore, the n-type contact layer 21 can be formed without ELO layer for decreasing dislocation, AlGaN layer for decreasing the pits or buffer layer. The substrate is a conductive substrate and n-type electrode is formed below the substrate so that the p-type electrode and the n-type electrode compose a face-type electrodes structure. In the above embodiment, the resonator of the semiconductor laser device is composed of the active layer 3, the p-type optical guide layer 24, n-type optical guide layer 42 and the cap layer 41.

Dwilinski: Paragraphs [0108]-[0111]

[0108] As described above, since the nitride semiconductor light emitting device according to the present invention comprises a gallium-containing nitride semiconductor layer prepared by crystallization from supercritical ammonia-containing solution, the crystalline quality can be recovered, while otherwise it would be degraded after forming the layer of quaternary or ternary compound. As the result there can be provided a laser device which is excellent in the lifetime property and current resistant property.

[0109] **Moreover, non-polar nitride A-plane or non-polar nitride M-plane is cut out from the bulk single crystal, the substrate for growth is prepared in this way, and the laser device can be formed on the A-plane or M-plane as an epitaxial growth face.** Thus, there can be obtained the laser device wherein the active layer is not influenced by the polarization and there is no cause of the deterioration of the performance such as the red shift of light emitting, recombination degradation and increase of the threshold current.

[0110] Furthermore, in case that the current confinement layer is formed at a lower temperature, the laser device can be obtained without the device degradation, and the process for forming the ridge can be omitted.

[0111] Moreover, the nitride layer can be formed in the form of single crystal at low temperature, so that the active In-containing layer is not influenced by degradation or damaged. Therefore the function and lifetime of the device can be improved.

<u>Dwilinski: Claim 10</u>

10. The light emitting device structure according to claim 8, wherein said active layer is a quantum well layer structure comprising at least one of InGaN well layer or InAlGaN well layer.

<u>Hata: Col. 9 lines 40-45</u>

In the aforementioned nitride-based semiconductor light-emitting device according to the third aspect, the semiconductor blocking layer preferably contains at least one element, selected from a group consisting of B, Ga, Al, In and Tl, and N. According to this structure, the semiconductor blocking layer can be formed with excellent crystallinity.

<u>Hata: Col. 52 line 43 - col. 53 line 4</u>

While InGaN is employed as the material for the MQW emission layer in each of the aforementioned first to eleventh embodiments, the present invention is not restricted to this but an emission layer may alternatively be prepared from a material having a band gap smaller than those of an n-type first cladding layer and an n-type second cladding layer. Particularly in a device provided with an emission layer having a quantum well structure of AlGaN, GaN or AlGaN/GaN/AlGaN exhibiting a larger band gap than InGaN, a current blocking layer, consisting of AlBGaN or AlGaN having a large Al composition, exhibiting a smaller lattice constant must be formed, leading to remarkable difference between the lattice constants of the current blocking layer and a GaN layer or a GaN substrate. Also in this case, effects similar to those of the aforementioned first to fourth embodiments can be attained by forming the current blocking layer only in the vicinity of a current path portion or reducing the thickness of the current blocking layer in a portion not in the vicinity of the current path portion. In this case, further, effects similar to those of the aforementioned fifth to eleventh embodiments can be attained by forming a semiconductor blocking layer on a dielectric blocking layer.

> While AlGaN is employed as the material for the n-type first and second cladding layers in each of the aforementioned first to eleventh embodiments, the present invention is not restricted to this but the n-type first and second cladding layers may be prepared from a material such as AlGaN, AlBN or AlBINGaN having a different lattice constant from the underlayer.

The above portions of Dwilinski describe a <u>cut surface</u> of a bulk single crystal, comprising a non-polar nitride a-plane or non-polar nitride m-plane, being used as a plane for depositing non-polar gallium-containing nitride layers. This differs from Applicants' claimed invention of growing non-polar a-plane (Al,B,In,Ga)N layers on a <u>grown surface</u> of non-polar a-plane GaN template layers on an r-plane substrate to form non-polar a-plane quantum wells. Indeed, nothing in the above portions of Dwilinski refers to a similar structure.

Moreover, these deficiencies of Dwilinski are not overcome by Hata. The cited portions of Hata merely describe the use of Boron in blocking layers or cladding layers. However, Hata, like Dwilinski, does not teach or suggest growing non-polar a-plane (Al,B,In,Ga)N layers on a grown surface of non-polar a-plane GaN template layers deposited on an r-plane substrate in order to form non-polar a-plane quantum wells.

Similarly, the deficiencies of Dwilinski combined with Hata are not overcome by Nagahama. Recall that Nagahama was cited only against Applicants' dependent claims 13-15 and for describing the doping of quantum well barriers.

Thus, Applicants' attorney submits that amended independent claims 1, 10 and 11 are allowable over Dwilinski, Hata, and Nagahama. Further, dependent claims 6-9 and 12-16 are submitted to be allowable over Dwilinski, Hata, and Nagahama in the same manner, because they are dependent on independent claims 1 and because they contain all the limitations of the independent claims. In addition, dependent claims 6-9 and 12-16 recite additional novel elements not shown by Dwilinski, Hata, and Nagahama.

III. CONCLUSION

In view of the above, it is submitted that this application is now in good order for allowance and such allowance is respectfully solicited.

Should the Examiner believe minor matters still remain that can be resolved in a telephone interview, the Examiner is urged to call Applicants' undersigned attorney.

Respectfully submitted,

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